

## PLANT ITEM MATERIAL SELECTION DATA SHEET

TCP-VSL-00001 (PTF)

Treated LAW Concentrate Storage Vessel

- Design Temperature (°F)(max/min): 237/40
- Design Pressure (psig) (max/min): 15/-8
- Location: incell
- PJM Discharge Velocity (fps): 40
- Drive Cycle: 17 % (at 40 fps)

Offspring items--

TCP-PJM-00001 - TCP-PJM-00008

ISSUED BY  
RPP-WTP PDC

Contents of this document are Dangerous Waste Permit affecting

Operating conditions are as stated on sheets 6 and 7

## Operating Modes Considered:

- Normal operating conditions

## Materials Considered:

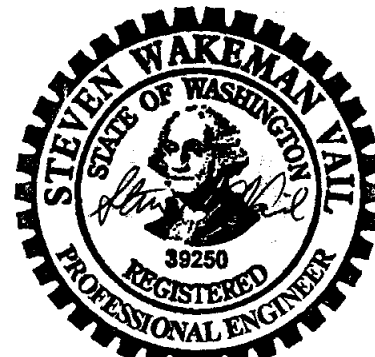
Material (UNS No.)	Relative Cost	Acceptable Material	Unacceptable Material
Carbon Steel	0.23		X
304L (S30403)	1.00		X
316L (S31603)	1.18	X	
6% Mo (N08367/N08926)	7.64	X	
Alloy 22 (N06022)	11.4	X	
Ti-2 (R50400)	10.1		X

Recommended Material: 316 (max 0.030% C; dual certified),

Recommended Corrosion Allowance: 0.040 inch (includes 0.024 inch corrosion allowance and 0.016 inch general erosion allowance; additional localized protection is required as discussed in section j)

## Process &amp; Operations Limitations:

- Develop flushing/rinsing procedure for acid and water



1/30/06

EXPIRES: 12/07/07

Please note that source, special nuclear and byproduct materials, as defined in the Atomic Energy Act of 1954 (AEA), are regulated at the U.S. Department of Energy (DOE) facilities exclusively by DOE acting pursuant to its AEA authority. DOE asserts, that pursuant to the AEA, it has sole and exclusive responsibility and authority to regulate source, special nuclear, and byproduct materials at DOE-owned nuclear facilities. Information contained herein on radionuclides is provided for process description purposes only.

This bound document contains a total of 7 sheets.

2	1/30/06	Issued for Permitting Use		Hmk	
1	1/13/05	Issued for Permitting Use	DLA	APR	MWH
0	9/25/03	Issued for Permitting Use	DLA	JRD	APR
REV	DATE	REASON FOR REVISION	PREPARER	CHECKER	APPROVER

## PLANT ITEM MATERIAL SELECTION DATA SHEET

### Corrosion Considerations:

This vessel receives a continuous feed from the treated LAW evaporator separator vessel. LAW concentrate is normally received at 122°F. Vessel is equipped with a steam injection system to maintain fluid temperature above the freezing point (77 to 100°F). TCP-VSL-00001 may also receive treated LAW from CXP-VSL-00026A/B/C or treated solids from UFP-VSL-00002A/B. This is expected to be an infrequent occurrence.

#### a General Corrosion

Based on Hamner's data (1981), 304 (and 304L) has a corrosion rate of less than 20 mpy (500  $\mu\text{m}/\text{y}$ ) in NaOH at 77°F and over 20 mpy at 122°F. He shows 316 (and 316L) has a rate of less than 2 mpy in 50% NaOH at up to 122°F. Dillon (2000) and Sedriks (1996) both state that the 300 series are acceptable in up to 50% NaOH at temperatures up to about 122°F. Davis (1994) is more precise and states the corrosion rate for 304L in NaOH will be less than about 0.1 mpy; Danielson & Pitman (2000), based on short term studies, suggest a corrosion rate of about 0.5 mpy for 316L in simulated LAW. These two references therefore corroborate Dillon and Sedriks. In addition, Divine (1992) showed that 304L corroded less than 316L in simulated complexant waste with fluorides and chlorides at 140°F. The corrosion rate of 304L after six months of testing was less than 0.2 mpy.

Ohl & Carlos (1994), in their review of the 242-A Evaporator, found that in waste similar to that expected in WTP, including the presence of radiation, the corrosion, of 304L after about 2 years of operation was less than the accepted variability of the plate. The NDE data are sufficiently uncertain to prevent definite conclusions from being drawn. However, a review by Zapp (1998) of the Savannah River evaporators showed the 304L shell had not been replaced after over 30 years of operation despite failure of the 304L evaporator tubes (which operate at higher temperature than the shell).

#### Conclusion:

At stated temperatures, 304L and 316L are expected to be sufficiently resistant to the waste solution with a probable general corrosion rate of less than 1 mpy.

#### b Pitting Corrosion

Chloride is well known for causing pitting in acid and neutral solutions. Dillon (2000) is of the opinion that in alkaline solutions, pH>12, chlorides are likely to promote pitting only in tight crevices. It is his opinion that 304L would probably be acceptable, but the use of 316L and especially a 6% Mo alloy would provide a benefit because of their better resistance to pitting by chlorides. Davis (1994) recommends the use of 316L over 304L. Dillon and Koch (1995) are of the opinion that fluoride will have little effect. In addition, Divine's work (1992) showed no hint of pitting after six months at 140°F under boiling heat transfer conditions. Revie (2000) notes that nitrate inhibits chloride corrosion. Therefore, the high nitrate concentrations in the waste are expected to be beneficial.

The apparent lack of pitting in the 242-A Evaporator suggests 304L is acceptable for the vessel. Based on Divine's work (1992), which was conducted in boiling waste at a bulk temperature of 140°F, 304L should be acceptable.

The vessel is equipped with wash rings capable of supplying water or acid. There is a possibility of neutral to acid conditions with halides present. Therefore, 316L is better than 304L.

#### Conclusion:

316L is recommended.

#### c End Grain Corrosion

End grain corrosion only occurs in metal with exposed end grains and in highly oxidizing acid conditions. This system is alkaline except possibly during cleaning. The temperature during cleaning must not be above 122°F.

#### Conclusion:

Not applicable to this system.

#### d Stress Corrosion Cracking

Several sources of cracking are present in this system: chloride and sodium hydroxide, both of which cause stress corrosion cracking of stainless steel.

The exact amount of chloride required to stress corrosion crack stainless steel is unknown. In part this is because the amount varies with temperature, metal sensitization, and the environment and also because chloride tends to concentrate under heat transfer conditions, by evaporation, and electrochemically during a corrosion process. Hence, even as little as

## PLANT ITEM MATERIAL SELECTION DATA SHEET

10 ppm can lead to cracking under some conditions. Generally, as seen in Sedriks (1996) and Davis (1987), stress corrosion cracking does not usually occur below about 140°F. Further, the use of "L" grade stainless reduces the opportunity for sensitization. From the above references, it also observed that alkaline conditions reduce the probability of the initiation of stress corrosion cracking to essentially zero. However, should a pit or crevice, including a deposit, be present under which the environment can become acid, then the alkaline environment will no longer have an effect.

Caustic cracking, according to Jones (1992), is not expected to occur below about 140°F for stainless steel. Zapp (1998) suggests cracking in waste is not a concern below about 280°F.

### *Conclusion:*

316L is recommended to offer greater protection against pitting and therefore reduce the likelihood of cracking.

### **e Crevice Corrosion**

Essentially the same comments and conclusions obtained for pitting are valid here.

### *Conclusion:*

Same as for pitting.

### **f Corrosion at Welds**

Corrosion at welds is not considered a problem in the proposed environment.

### *Conclusion:*

Corrosion at welds in the vessel is not a concern.

### **g Microbiologically Induced Corrosion (MIC)**

MIC typically is not prevalent in high pH solutions. Borenstein (1988) states most microbes prefer a pH below 7 though some have been grown at above 9.5. Further, microbial growth is normally not a concern in tanks.

### *Conclusion:*

MIC is not expected to be a concern in the vessels.

### **h Fatigue/Corrosion Fatigue**

Corrosion fatigue does not appear to be a concern.

### *Conclusions:*

Not a concern.

### **i Vapor Phase Corrosion**

Because of the highly alkaline conditions, no free HF or HCl is expected to be present in the vapor phase and no uniform/general corrosion is expected. A rinsing procedure should be developed to prevent formation of deposits. The nitrate and hydroxide in the waste are also present in any deposits and should minimize pitting.

### *Conclusion:*

General corrosion will not be a concern. Use of 316 is recommended as more pitting-resistant.

### **j Erosion**

Based on past experiments by Smith & Elmore (1992), the solids are soft and erosion is not expected to be a concern for the vessel wall. Based on 24590-WTP-RPT-M-04-0008, a general erosion allowance of 0.016 inch is adequate for components with maximum solids content up to 27.3 wt%. Additional 316L stainless steel should be provided as localized protection for the applicable portions of the bottom head to accommodate PJM discharge velocities of up to 12 m/s with normal maximum solids concentrations of 3.4 wt% and maximum solids concentrations of 20 wt% with a usage of 77 % operation as documented in 24590-WTP-M0C-50-00004. TCP-VSL-00001 requires at least 0.164-inch additional protection. The 20 wt% is considered to be conservative. The fraction of time the solids concentration is expected to be at maximum is 10 %. During normal operation, 90 % of the time, the solids content of TCP-VSL-00001 is expected to be 3.4 wt%.

## PLANT ITEM MATERIAL SELECTION DATA SHEET

The wear of the PJM nozzles can occur from flow for both the discharge and reflood cycles of operation. At least 0.113-inch of additional 316L stainless steel should be provided on the inner surface of the PJM nozzle to accommodate wear due to PJM discharge and suction velocities with normal solids concentrations of 3.4 wt% and a maximum solids concentration of 20 wt% with a usage of 77 % operation as documented in 24590-WTP-MOC-50-00004.

*Conclusion:*

The recommended corrosion allowance provides sufficient protection for erosion of the vessel wall. Additional localized protection for the bottom head will accommodate PJM discharge velocities and for the PJM nozzles will accommodate PJM discharge and reflood velocities.

### **k Galling of Moving Surfaces**

There are no moving surfaces within the vessels.

*Conclusion:*

Galling is of no concern in these vessels.

### **l Fretting/Wear**

There are no contacting surfaces that are part of the vessel.

*Conclusion:*

Fretting and wear are not of concern.

### **m Galvanic Corrosion**

The vessel contains no dissimilar metals.

*Conclusion:*

Galvanic corrosion is not a concern.

### **n Cavitation**

None expected.

*Conclusion:*

Cavitation is not a concern.

### **o Creep**

Creep is a high temperature phenomenon, occurring at greater than about 932°F.

*Conclusion:*

Creep is of negligible concern.

### **p Inadvertent Nitric Acid Addition**

Higher chloride contents and higher temperatures usually require higher alloy materials. Nitrate ions inhibit the pitting and crevice corrosion of stainless alloys. Furthermore, nitric acid passivates these alloys; therefore, lower pH values brought about by increases in the nitric acid content of process fluid will not cause higher corrosion rates for these alloys. The upset condition that was most likely to occur is lowering of the pH of the vessel content by inadvertent addition of 0.5 M nitric acid. Lowering of pH may make a chloride-containing solution more likely to cause pitting of stainless alloys. Increasing the nitric acid content of the process fluid adds more of the pitting-inhibiting nitrate ion to the process fluid. In addition, adding the nitric acid solution to the stream will dilute the chloride content of the process fluid.

*Conclusion:*

The recommended materials will be able to withstand a plausible inadvertent addition of 0.5 M nitric acid for a limited period.

## PLANT ITEM MATERIAL SELECTION DATA SHEET

## References:

1. 24590-WTP-MOC-50-00004, Rev. D, *Wear Allowance for WTP Waste Slurry Systems*
2. 24590-WTP-RPT-M-04-0008, Rev. 2, *Evaluation Of Stainless Steel Wear Rates In WTP Waste Streams At Low Velocities*
3. 24590-WTP-RPT-PR-04-0001, Rev. B, *WTP Process Corrosion Data*
4. CCN 130172, Divine, JR, 1986, Letter to A.J. Diliberto, Reports of Experimentation, Battelle, Pacific Northwest Laboratories, Richland, WA 99352
5. CCN 130174, Divine, J. R. and W. C. Carlos, 1992, *Assessment of Known Degradation and Existing Corrosion Studies on Steel*, Presented at the High-Level Waste Tank Systems Structural Integrity Workshop, February 19-20, 1992, Richland, Washington
6. Borenstein, SW, 1988. *Microbiologically Influenced Corrosion Of Austenitic Stainless Steel*, Chang, J. Y., 1998, Corrosion Monitoring and Control for Tanks 8D-1 & 8D-2, Report of the Fourth Annual Corrosion Meeting, West Valley, New York.
7. Danielson, MJ & SG Pitman, 2000, Corrosion Tests of 316L and Hastelloy C-22 in Simulated Tank Waste Solutions, PNWD-3015 (BNFL-RPT-019, Rev 0), Pacific Northwest Laboratory, Richland WA.
8. Davis, JR (Ed), 1987, *Corrosion, Vol 13*, In "Metals Handbook", ASM International, Metals Park, OH 44073
9. Davis, JR, 1994, Stainless Steels, In ASM Metals Handbook, ASM International, Metals Park, OH 44073
10. Hamner, NE, 1981, Corrosion Data Survey, Metals Section, 5th Ed, NACE International, Houston, TX
11. Jones, RH (Ed.), 1992, Stress-Corrosion Cracking, ASM International, Metals Park, OH 44073
12. Koch, GH, 1995, Localized Corrosion in Halides Other Than Chlorides, MTI Pub No. 41, Materials Technology Institute of the Chemical Process Industries, Inc, St Louis, MO 63141
13. Ohl, PC & WC Carlos, 1994, Hanford High-Level Evaporator/Crystallizer Corrosion Evaluation, Presented at Corrosion 94, NACE International, Houston TX 77218
14. Revie, WW, 2000. Uhlig's Corrosion Handbook, 2nd Edition, Wiley-Interscience, New York, NY 10158
15. Sedriks, AJ, 1996, Corrosion of Stainless Steels, John Wiley & Sons, Inc., New York, NY.
16. Smith, H. D. and M. R. Elmore, 1992, *Corrosion Studies of Carbon Steel under Impinging Jets of Simulated Slurries of Neutralized Current Acid Waste (NCAW) and Neutralized Cladding Removal Waste (NCRW)*, PNL-7816, Pacific Northwest Laboratory, Richland, Washington.
17. Zapp, PE, 1998, *Preliminary Assessment of Evaporator Materials of Construction*, BNF-003-98-0029, Rev 0, Westinghouse Savannah River Co., Inc for BNFL Inc.

## Bibliography:

1. CCN 130170, Blackburn, LD to PG Johnson, Internal Memo, Westinghouse Hanford Co, Evaluation of 240-AR Chloride Limit, August 15, 1991.
2. CCN 130171, Ohl, PC to PG Johnson, Internal Memo, Westinghouse Hanford Co, Technical Bases for Cl- and pH Limits for Liquid Waste Tank Cars, MA: PCO:90/01, January 16, 1990.
3. CCN 130173, Dillon, CP (Nickel Development Institute), Personal Communication to J R Divine (ChemMet, Ltd., PC), 3 Feb 2000.
4. Kirch, N. W., 1984, Technical Basis for Waste Tank Corrosion Specifications, SD-WM-TI-150, Rockwell Hanford Operations, Richland, Washington.

## PLANT ITEM MATERIAL SELECTION DATA SHEET

24590-WTP-RPT-PR-04-0001, Rev. B  
WTP Process Corrosion Data

## PROCESS CORROSION DATA SHEET

Component(s) (Name/ID #)

Treated LAW concentrate storage vessel (TCP-VSL-00001)

Facility

PTF

In Black Cell?

Yes

Chemicals	Unit <sup>1</sup>	Contract Maximum		Non-Routine		Notes
		Leach	No leach	Leach	No Leach	
Aluminum	g/l	3.9E+01	3.5E+01			
Chloride	g/l	1.8E+01	2.0E+01			
Fluoride	g/l	1.8E+01	2.0E+01			
Iron	g/l	2.8E+00	2.9E+00			
Nitrate	g/l	2.7E+02	2.9E+02			
Nitrite	g/l	8.2E+01	8.9E+01			
Phosphate	g/l	5.9E+01	6.3E+01			
Sulfate	g/l	3.1E+01	3.4E+01			
Mercury	g/l	9.0E-01	3.1E-02			
Carbonate	g/l	1.3E+02	1.1E+02			
Undissolved solids	wt%					
Other (NaMnO <sub>4</sub> , Pb,...)	g/l					
Other	g/l					
pH	N/A					
Temperature	°F					Note 3
						Note 2

List of Organic Species:

## References

System Description: 24590-PTF-3YD-TCP-00001, Rev 0

Mass Balance Document: 24590-WTP-M4C-V11T-00005, Rev A

Normal Input Stream #: TLP02, TCP03

Off Normal Input Stream # (e.g., overflow from other vessels): FRP03, UFP08

P&amp;ID: 24590-PTF-M6-TCP-P0001, Rev 0

PFD: 24590-PTF-M5-V17T-P0006, Rev 0

Technical Reports:

## Notes:

1. Concentrations less than  $1 \times 10^{-4}$  g/l do not need to be reported; list values to two significant digits max.
2. T normal operation 122 °F to 150 °F (24590-PTF-MVC-TCP-00001, Rev 0)
3. pH approximately 12 to 14

## Assumptions:

**PLANT ITEM MATERIAL SELECTION DATA SHEET**24590-WTP-RPT-PR-04-0001, Rev. B  
WTP Process Corrosion Data**4.12.1 Treated LAW Concentrate Storage Vessel (TCP-VSL-00001)****Routine Operations**

The treated LAW concentrate storage vessel (TCP-VSL-00001) is designed to receive a continuous feed from the treated LAW evaporator separator vessel (TLP-SEP-00001). The treated LAW concentrate is then transferred in batches to the LAW vitrification facility, as required for continuous glass production. A batch transfer (~9300 gal) will be required each time one of the concentrate receipt vessels (LCP-VSL-00001/2) in the LAW vitrification facility is empty. Capability is also maintained to transfer to a future LAW vitrification facility, per WTP contract requirements (DOE 2000). The batch transfer frequency may fluctuate, as it is based on a design feed rate of LAW fluid to the glass melters. The treated LAW concentrate storage vessel (TCP-VSL-00001) is designed to provide 7 days of lag storage in the event that the PT facility is not able to provide concentrate feed. The lag storage batch volume is based on the average treated LAW rate needed to support ILAW glass production of 80 t/day.

The normal influent temperature of the LAW concentrate is 122 °F. TCP-VSL-00001 is equipped with a high-pressure steam injection system (109 psig and 343 °F from the Basis of Design, 24590-WTP-DB-ENG-01-001) to maintain fluid temperature above the freezing point (77 to 100 °F), depending on envelope being processed. This is approximately the point at which crystallization or precipitation of solids occurs. Should solids form, or be transferred to TCP-VSL-00001, PJMs are available to aid in the suspension of particles and homogenize the LAW concentrate for transfer. Wash rings and a high-pressure steam ejector system are installed for cleaning or decontamination of the vessel and internals. TCP-VSL-00001 vents to a scrubber, PVP-SCB-00002, via a collection header.

The PJMs in TCP-VSL-00001 will be operated to suspend solids and maintain a homogeneous mixture. They can be active as long as the liquid level in the vessel is above the PJM low-level setpoint.

**Non-Routine Operations that Could Affect Corrosion/Erosion**

TCP-VSL-00001 may also receive treated LAW from the IX treated LAW collection vessels (CXP-VSL-00026-A/B/C), bypassing the treated LAW evaporator system. Under infrequent operating conditions, treated solids from the ultrafiltration feed vessels (UFP-VSL-00002A/B) may also be blended with the treated LAW concentrate in TCP-VSL-00001 if the solids meet the specifications for LAW vitrification.

This is not expected to occur very often and requires a jumper, not normally installed, on the provided transfer line.